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which have thus far been collected in America; they seem to illustrate the futility of attempting to define satisfactorily varieties, and to warrant their abandonment and the substitution of "*forms*," varying with the locality, as has been suggested by Professor Nordstedt, of Sweden, and is the practice in the case of the polymorphous species, *C. fœtida* A. Br., *C. intermedia* A. Br., and many others.

A few of the more remarkable forms may still retain a specific name, as var. *Oahuensis* A. Br., perhaps var. *gracilis* Allen, and a few others; or it might even be admissible to bestow a specific name on each constant form as a convenient method of designating its peculiarities. For the present, however, while our knowledge of the American forms is yet so incomplete, we prefer to classify them as above.

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THE LOESS OF NORTH AMERICA.

BY R. ELLSWORTH CALL.

THE term loess is a purely provincial one, having been originally applied by the residents of the Rhine valley to a certain comparatively recent formation bordering that stream. It is the anglicized form of the German *lösz*, itself a derivative of the verb *lösen*, to loose or to detach. It was evidently bestowed in allusion to the loose texture of that loam-like soil, and, in its present acceptation, is to be regarded as nearly the equivalent of the English *loam*.

Historical.—The earliest notice of the loess in America appears to have been in connection with various exploring expeditions sent out by the General Government. That of Lewis and Clark, made between the years 1803–1806, to the Rocky mountains, by way of the Missouri river, called attention to the remarkable character, both physical and lithological, of the bluffs along that stream, but for aught the report contains their true geological position and history were not recognized. Later, the celebrated artist, Catlin, in his letters to England from the Northwest,[1] gives a very accurate and graphic account of the Missouri river bluffs, in which he mentions certain of their remarkable physical peculiarities.

The real geological character of this formation in the United

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[1] Catlin's N. A. Indians, Vol. I, p. 19, 1876. London, Chatto & Windus.

States seems to have been first surmised by Sir Charles Lyell, whose observations, however, were confined to the lower Mississippi, and notably to this deposit in the State of that name. He had traveled extensively in Europe, and in the progress of his journeyings had taken occasion to study somewhat carefully the Rhenish loess. In the first edition of his "Elements of Geology," published in 1838, he mentions at some length the loess deposits of the Rhine, and states that it is mineralogically and chemically similar to the famous deposits in the delta of the Nile. He also offers a few considerations touching its origin, to which it is not here necessary to make reference. Later, in 1846, while Lyell was in this country, Professor Wailes, of the Mississippi Geological Survey, drew his especial attention to the deposit as laid down in certain ravines in Adams county, in that State. In the subsequently published account of his travels, Mr. Lyell remarks that "the resemblance between this loam and the fluviatile silt of the valley of the Rhine, generally called loess, is most perfect."[1] Following him, most writers on the loess of the Mississippi valley consider it the counterpart of the Rhenish formation. About this period a large portion of the great hydrographic basin of the Mississippi was being for the first time geologically explored under the general and various State governments, so that discoveries of this deposit over large areas appearing *to border upon the principal streams only,* were both numerous and important. In Iowa, the first study of the loess was made by Dr. D. D. Owen, and reported upon to the General Government in his "Geological Survey of Wisconsin, Iowa, and Minnesota," published in 1852. He crossed the state from Des Moines, then a mere military post, to its western limit. Commenting on the rock structure as he advanced, he says:[2] "On approaching the Missouri, the hills bordering the extensive bottoms, known as Council Bluffs, attract particular attention, not only from their contour, but from their geological formation. Where vegetation has been removed from their slopes, they are seen to be composed chiefly of a fine ash-colored, silicious marl, or loam, effervescing with acids. In favorable situations many species of terrestrial and fluviatile shells were discovered, of the same species as are found in similar deposits in the Wabash valley, which are considered contemporaneous with the loess of the Rhine." At about the same time loess was found by Whittlesy[1] on the south shore of Lake Erie, and from the presence of fresh-water shells he likewise inferred that the formation belonged to the age of the Rhenish lacustrine deposits. In writing on the superficial geology of the Lake Superior section, E. Desor concludes that "though the terraces of Mackinac differ widely in composition from the loam, or loess, of Lakes Erie and Huron, yet, the fact that both are posterior to the drift and occur at similar heights on the coast of the same lake, seems to warrant the conclusion that they may have been simultaneous." Whether those deposits are to be considered *true loess*, we are not prepared to state.

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[1] Quoted by Wailes in "Report on the Agriculture and Geology of Mississippi," 1854, p. 213.

[2] *Op. cit.*, p. 132.

The field of discovery and study now again reverted to the south, for, in 1854, was published Wailes' account of this formation as existing in Mississippi. One year later appeared Swallow's "First and Second Reports on the Geology of Missouri," in which is given, for the first time, a full account of the loess, to which Professor Swallow applies the name of "bluff formation." This work was followed in the succeeding year, 1856, by Owen's "Report on the Geology of Kentucky," in which occur numerous references to the loess of that State. In the same year was published Volume III of the Pacific Railroad Reports, in which W. P. Blake, in giving an account of the geology of the thirty-fifth parallel, extends the geographical distribution of the loess to twenty-six miles above Fort Washita on the Red river, and quotes the observations of Shumard, made in the same section during the explorations under charge of Captain Marcy, in 1852.[2] In 1860, E. W. Hilgard, in his "Agriculture and Geology of Mississippi," gave the most complete account of the loess of the south yet published. In Nebraska, during the year 1867, it was studied by Dr. Hayden, and later by Prof. Aughey, who published an account of the surface geology of that State in Hayden's Annual Report for 1874. Meanwhile, Safford in Tennessee had published, in 1869, his account of the geology of that section; and White's "Geology of Iowa," which appeared in 1870, contains the most finished treatment of the Iowa loess, and incidentally that of Missouri and Nebraska, which has come under notice. The last elaborate study, to which it is here necessary to make reference, is contained in the "Sketches of the Geology and Physical Geography of Nebraska," by Professor Samuel Aughey, which is, mainly, so far as the loess is concerned, an extension of his previously published paper in the report of the Hayden survey above mentioned.[1]

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[1] Report on the Geology of the Lake Superior Land District, 1851, Foster & Whitney. Pt. II, p. 248.

[2] "Exploration of the Red river of Louisiana," pp. 28–29. The common error is here made of referring the fossils found to European species. *Pupa muscorum*, *Succinea elongata*, and *Helix plebium*, are named.

From these facts it will have been gathered that the loess is of wide distribution in the great central basin of the United States, to which it seems wholly confined. It is found in the States of Ohio, Indiana, Michigan, Iowa, Kansas, Nebraska, Illinois, Tennessee, Alabama, Mississippi, Louisiana, Arkansas, Missouri, Kentucky, and in the Indian Territory; but *in every instance* is apparently confined to the higher lands along the larger streams. Its superficial extent is greatest in Nebraska, where, according to Aughey,[2] its area is three-fourths that of the State, or 56,994 square miles.[3] In Iowa its superficial area is estimated by White[4] at about 5000 square miles, but his calculations included only those sections along the Missouri, inasmuch as he was evidently unacquainted with its existence in Central Iowa, and in the eastern portion of the State. Its area appears to be next greater in Missouri, which is, indeed, but the southern extension of the Iowa and Nebraska deposit. In most of the other States where it occurs its area is comparatively small.

Physical characters.—Observers agree, in the main, with reference to the physical features of this formation. Its material is exceedingly fine, very silicious as proven by numerous analyses, ashy color with slight yellowish tinge—normally; and often highly calcareous. In all these respects it agrees entirely with published descriptions of foreign loess. *In situ* it presents a remarkably homogeneous structure, usually appearing in massive walls without, or with but faint, lamellation, the latter feature being purely local. So perfect is the homogeneity that very careful examinations of specimens of soil from the Missouri valley, and the valleys of the Des Moines and Iowa rivers, failed to reveal even slightly marked physical differences. A peculiar feature of the loess—in all parts of the world—is the presence of numerous calcareous concretions—the *löessmännchen* of the Rhenish deposits —which occur in zones, at varying distances throughout the mass. They assume all possible shapes from the spherical (Plate v, Fig. 4) through the spheroidal to the oblong; in all cases they are more or less numerously studded with roughened projections. No one shape seems to obtain more than another, and not unfrequently several are found cemented together, forming an eccentric single mass. They are certainly characteristic of the loess, for that formation nowhere occurs without their presence. They are decidedly hydraulic as would be naturally inferred from their constitution. In no case have I ever observed fossils—either mollusks or vegetable matters—acting as a nucleus. On one occasion, 2803 of these bodies were crushed with that especial point in view. In nearly every instance, 2789, they were found to contain loose fragments broken by some means from their inner walls, but no foreign substance whatever could be detected.[1] In the remaining fourteen specimens, while the concretions were hollow, they yet contained loose particles of no substance whatever. Not a single specimen was solid throughout. That they were originally solid, or of a pasty consistency, is not to be doubted, as a study of the inner surface reveals. They all present a deeply fissured interior (Plate v, Fig. 1),[2] consequent on the evaporation of water and subsequent contraction. In the vast majority of cases the pyramidal masses of the interior showed distinct irregularly concentric lines of growth, or rather of accretion (Plate v, Fig. 2). The presence of these zones and the peculiarly granulated surfaces of the crushed masses, with entire absence of distinct crystallization when viewed under the microscope[3] complicates somewhat the problem of their origin. Professor J. D. Whitney says of them[1] that they "have been formed in the loess by infiltration along the lines of cleavage and resultant chemical action on calcareous matter occurring in large quantity along certain planes."

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[1] It is not possible to note here all the minor papers, however important, that bear upon the different aspects of the loess. The reader is referred to the accompanying bibliography for all other details of publication.

[2] Sketches, &c., p. 265.

[3] "I should judge that the true loess covered about one-fourth to one-fifth of the State, not more. It is largely confined to the borders of streams and the eastern portion." Professor Hayden, *in litt.*

[4] Geology of Iowa, Vol. 1, p. 127.

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[1] On being shaken a rattling sound is produced, owing to these separated fragments violently striking against the inner walls of the concretions. This has earned for them among the boys of this city, the appellation of "rattle-boxes," for which reason they seem to be in great demand.

[2] View of a transverse section of spherical loess concretion, showing interior: *a*, peripheral layer, highly calcareous; *b*, pyramidal appearance of interior caused by the numerous deep fissures *c*; natural size.

[3] Professor A. F. Gray, *in litt.* So also my own examinations.

It should be noted, in framing any theory on these peculiar bodies, that *without exception* the fissures of the interior surface end with the outer calcareous envelope, as shown in Plate v (Fig. 1 and 2, *c* and *a*). So also should be considered the numerous rugosities or protuberances more or less thickly studded over their surfaces (Plate v, Fig. 3).[2] Further, there often occur, in the pyramidal masses of the interior, numerous small black masses, apparently carbonaceous, the true nature of which has not yet been satisfactorily determined. I am, however, disposed to consider these concretions as a result of chemical changes in the composition of the loess itself through the action of carbonic and various of the humus acids. These exert, as is well known, a marked action upon certain mineral substances contained in soils, as notably upon carbonate of lime.[3] Whether there may have been an original foreign nucleus about which accretion began I am unable to say, but the *fact* is, that in none of the above mentioned 2803 specimens could any such nucleus be found.

On one other point the writer's observations lead to negative results. In *every case*, even when from considerable depths, the concretions are of a stony hardness. One observer[4] states that "when first exposed, most of these concretions are soft enough to be rubbed fine between the fingers, but they gradually harden by being exposed to the atmosphere." Furthermore, the portion interior to the outer calcareous envelope is largely, more than one-half, carbonate of lime. A little more than one-third is silica, with a small per centage of alumina. We have here, then, the conditions which produce their hydraulic properties, a fact in itself sufficient, almost, to lead to a belief in their universal hardness.

Another feature of the loess remains to be noticed, which is in some particulars its most remarkable characteristic. Reference is here made to the almost or quite vertical planes of cleavage. Wherever streams, both great and small, have eroded channels through the deposit, or when they undermine the resulting cliffs, the masses that become detached break off in planes parallel to the original cleavage planes. This is especially remarkable since the material of the loess is not cohesive, and not at all plastic, unless thoroughly saturated with water. The use to which this feature has been put is well illustrated by the great work of Richthofen on China. In our country it is most common to meet with bluffs that are more or less rounded, a condition due to the action of rains and frosts.

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[1] AMERICAN NATURALIST, Vol XI, p. 709.

[2] This figure represents a form of twin concretion fairly common in the loess deposits of this city, Des Moines, Iowa.

[3] *Vide* Darwin's "Vegetable Mould and Earth Worms," p. 140, *Ibid.* p. 240. In this wonderful volume the reader will find numerous facts bearing on this point.

[4] Aughey, Sketches, &c., p. 266.

Microscopical and Chemical Features.—The soil of the loess presents an unusually beautiful field when viewed with a good working microscope. A number of such examinations were made (1) of soil as taken *in situ*, in which were presented minute granules of pure silica of an average diameter of $\frac{1}{500}$ to $\frac{1}{1000}$ of an inch; (2) of soil after treatment with strong nitric acid, when the same features were prominent, the silica granules merely appearing somewhat brighter. None of the olive-green crystalline particles, found by Pumpelly in the Chinese loess, were to be found, while in our examinations, as in his, there were no remains of minute organisms, such as diatoms.[1] In most cases the granules were devoid of the sharp angles which recently detached particles of silicious rocks give. This may, in part at least, be due to the action of the acids mentioned above, and in part to attrition against one another. They were all irregularly ovoid and somewhat translucent bodies, but occasionally discolored by some one or another of the iron oxides.

Numerous analyses made by several observers, rate the approximate quantity of silica in the loess soil at from seventy-five to eighty per cent. Blow-pipe analysis, conducted solely with a view to qualitative ends, gave, as constituents of the soil from the Missouri river and Des Moines valley deposits, water, phosphorus (trace), sodium (trace), iron (trace), calcium, magnesium, aluminum and silica. To present more clearly the nature of the soil, its value agriculturally, and as anticipatory of its mode of origin, the following table will be found useful and instructive. I give, also, in juxtaposition, the average of the results of Bischoff's examination of the Rhenish loess, to enable ready comparison:

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[1] The examinations were conducted by the writer and Dr. A. G. Field, to whom the instrument used belonged. It was a Zentmayer's Centennial improved stand, with the A eye-piece and 8-10 objective.

TABLE SHOWING THE CHEMISTRY OF THE LOESS.

Composition of Missouri Loess.	Average of four Analyses by Litton.	Composition of Nebraska Loess.	Average of five Analyses by Aughey.	Composition of Iowa Loess.	Average of two Analyses by Emery.	Composition of Rhine Loess.	Average of five Analyses by Bischoff.
Silica	77.4275	Insoluble (silicious) matter	81.334	Insoluble (silicious) matter	84.85	Silicic acid	72.136
Alumina and peroxide of iron	12.83	Ferric oxide	3.854	Ferric oxide Alumina	3.77	Alumina and peroxide of iron.	15.362
Lime	3.2425	Alumina	0.742			Lime[1]	0.02
Magnesia	1.4975	Lime carbonate	6.058	Calcium carbonate	8.33	Magnesia	0.298
Carbonic acid and water	2.765	Lime phosphate	3.584	Magnesium carbonate	1.70	Potash and soda	2.094
		Magnesia carbonate	1.294	Moisture	1.10	Carb. lime[2]	15.895
		Potassa	0.316	Organic matter, traces, and loss	1.25	Carb. magnesia	3.615
		Sodium	0.154			Loss	1.114
		Organic matter	1.06				
		Water	1.086				

[1] No lime appeared in analyses numbers 3, 4 and 5.

[2] No carbonate of lime nor carbonate of magnesia appeared in analyses numbers 2, 3 and 5. Hence in these cases the average of the *two* in which they appear is given.

PLATE V.

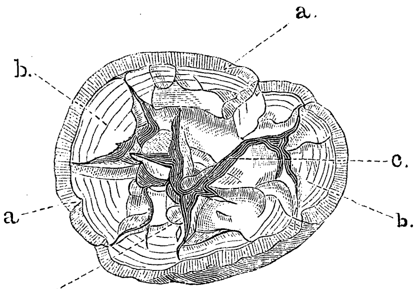


FIG. 1.

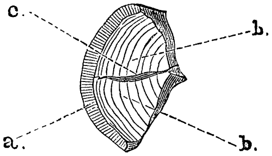


FIG. 2.

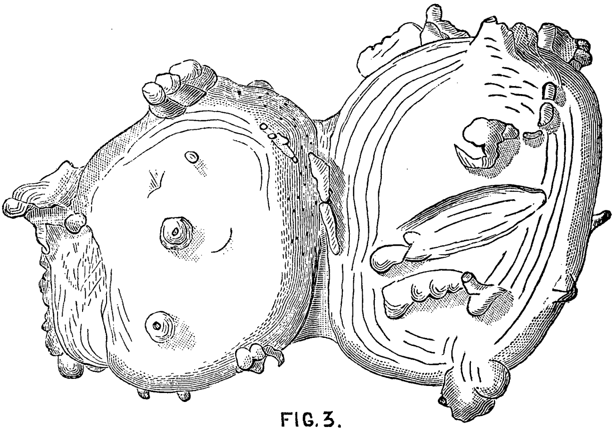
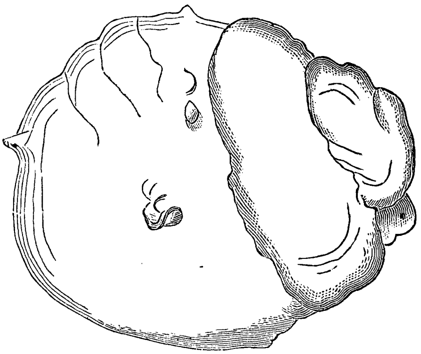


FIG. 3.



A.F. GRAY. DEL.

FIG. 4.

Loess Concretions.

The composition of the concretions is essentially the same as that of the loess proper, though some of the elements do not appear therein. After treatment of 100 grains of the interior with strong muriatic acid, there remained, after thorough washing and drying, thirty-one grains of insoluble residue, or nearly one-third, which was plainly silica. Dr. Litton's analyses of concretions from the loess of Missouri, the only ones, I believe, on record in America, gave him :

Residue, insoluble in hydrochloric acid, principally silica	35.08
Alumina and peroxide of iron	5.29
Carbonate of lime	58.33
Carbonate of magnesia	0.77

The absence of a greater amount of carbonaceous material in the loess soil proper is matter of common remark. It may be accounted for, perhaps, by the fact that carbon in the soil tends generally to oxidize and disappear, save where there is an accumulation of water and a cool climate.[1] Its presence in the shape of "organic remains" seems to have been noticed, in chemical manipulations, only by Aughey and Emery, as noted in the table.

Method of Deposition.—The older geologists, without exception, seem to have agreed either upon the fluviatile or lacustrine origin of these famous deposits. Nor does this decision appear to have been questioned until the publication of Von Richthofen's *China*, in which that celebrated geologist elaborated his views, based upon extensive and painstaking study of the loess of that country. His views are radically distinct from those of his predecessors in the same field of investigation. They are based upon a study of the Chinese loess extending over a period of five or six years, while engaged in certain other investigations under the auspices of the Prussian Government. His observations were published at length in the work to which allusion has been made, in 1877, but not having access to the original containing them, I am obliged to formulate a *résumé* of his theory from reviews which have appeared in the several scientific journals, This is deemed necessary for the reason that though based upon the Chinese loess, Richthofen expressly states that in his judgment the theory of that deposit is applicable to the loess wherever on the globe it may be found.

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[1] *Vide* Darwin's "Naturalist's Voyage around the World," ed. of 1876, pp. 286, 287. Contains some interesting facts relative to peat formation.

Richthofen holds[1] that the loess is a subaërial accumulation, due to the drifting action of the winds; to transportation by rivulets from the hills immediately adjacent to each loess basin ; and to the mineral material left over the basin by the growing grasses and other plants. The material for wind transportation is gathered from the circumjacent or even from remote rocks which were decomposed or disintegrated by alternate changes in temperature or humidity. The plants that covered the great plains served to stop the wind-drifted particles, and thus kept the accumulation ever in progress. Observing certain local differences in the appearance of the deposits which he studied, he invented the distinctions of *land-loess* and *lake-loess.* The last named was designed to account for certain indications of stratification or lamellation not to be adequately explained by the wind theory.[2] The present system of drainage he accounts for much as do most other geologists, the main difference consisting in the assumption of great changes of climate causing heavy rains which led to floods. The usual indication of changes of level are also noticed by him, but they seem to have led to novel interpretation. Von Richthofen states that he found no evidence of a fresh-water *fauna* in the formations he studied, but land forms of molluscous and other animals abounded. In this he is directly opposed by the earlier and original observations of Pumpelly[3] who distinctly states that he found fresh-water forms in the loess regions on the borders of Mongolia. The points, however, which are mainly relied on by the Baron, appear to be (1) the presence of root-marks occurring throughout the formation; (2) absence of fresh-water or other aquatic life-forms; and (3) absence of stratification. Both the second and third of these propositions are met by the repeated statements of numerous careful observers, who have found aquatic and semi-aquatic forms in many localities. The presence of the semi-aquatic forms alone—such as *Succinea*—which are indicative of a moist station, effectually negatives the assumption of a "dry, elevated area swept by fierce winds." The first proposition has been met by the studies of Professor J. E. Todd,[1] who has shown that from the law which evidently obtains, that root-marks vary in frequency inversely as their distance below the present surface, "unusual care is necessary to interpret observations correctly." The conclusion reached by that observer is, that when correctly interpreted the distribution of root-marks opposes the sub-aërial hypothesis.

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[1] This view was *first* advanced by him in 1870 in a memoir on the geology of the provinces of Honan and Shansi.

[2] *Vide* Am. Jour. of Sci. and Arts, Vol. XIV, p. 490, series third.

[3] *Vide* Smithsonian Contributions to Knowledge, No. 202, pp. 42–43. That this author at that writing was convinced of the fresh-water origin of the Chinese loess is attested by the following language. He says : "That this deposit was formed in fresh water, is shown by the presence of the shells found in the terrace of the Te Hai. The uniform character of the loam in the different basins, and in all parts of the same basin, its great extent, and the fineness of the material of which it consists, are conditions which prove that it is not of a local origin, or derived from the detritus of neighboring shores, but that it was brought into the lakes by one or more large rivers which must have drained an area of great extent. Now throughout the region in question, the only rivers are those of the Yang Ho and Sankang Ho basin, and independently of the fact that these streams drain a very small area, the valley systems of these were almost entirely occupied by the lakes." *Op. cit.*, p. 42.

On p. 43 he derives the following argument from physical geography : "Indeed, all the information we possess concerning this region, goes to show that it has been the basin of a great lake, which once extended from the northern bank of the Yellow river southward to the mountains crowned by the Great Wall." These words were penned eleven years before the work of Richthofen appeared.

It will have been observed that the original statements and inferences of Pumpelly and those of Richthofen were distinct and opposed. The former recognized the agency of water alone as sufficient to explain the phenomena he studied, while the latter called to the aid of the winds a lake-basin, which in turn necessitated his artificial distinctions of lake-loess and land-loess. That such a distinction is wholly inapplicable to American deposits—unquestionably true loess—is patent, for the reasons that it presents a perfect homogeneity of structure, entire absence of any such modification as is seen in dunes—such as are true wind structures—and does present at several localities a faintly stratified appearance. Besides, the climatic conditions required by this theory of the Chinese loess, seem to have had no counterpart in climatic changes over the areas covered by our loess.

The argument for the lacustrine origin of the American deposits has been in part anticipated in the foregoing. But there should be added the facts that here the formation is confined to river valleys, and the high lands immediately adjacent; that of the fineness of its material, its composition, its rounded or triturated form, the fossils imbedded in it, and the unmistakable action of water in assorting; that of general continental depression synchronous with its formation; that of the vast quantity of the material and its deposition alike on hill and in valley. These severally and together are fatal to the hypothesis of Von Richthofen.[1] It is nevertheless beyond question that the loess, *after deposition*, has been somewhat modified by the action of strong winds, but the evidences of such action are purely local. The great dust-storms of Western Iowa, extending far beyond the central portions of the State, which occurred in the spring of 1880, will long be remembered in the annals of Iowa. For days the air was filled with fine dust, coming from the south-west, the locality of the greatest areas of loess and the prevailing quarter of the winds. That much of this fine material was carried miles further away I have no doubt. The main effect however, of such wind storms, would be the denudation of the windward, and the deeper covering of the leeward bases and sides of hills.

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[1] Proc. A. A. A. S., 1878, Vol. XXVIII. "Richthofen's Theory of the Loess, in the light of the Deposits of the Missouri." Professor Todd here shows that the lower limit of root-marks—about forty-five feet—is approximately parallel with the present surface. A table accompanies giving the depth of penetration of roots in the loess. Those of the scouring rush (*Equisetum lævigatum* Braun) reached a point more than twenty-five feet beneath the surface.

Fossils.—The mollusks of the loess belong, with perhaps a single exception, to genera which now flourish in regions adjacent to the formation. They are *Limnæa*, *Physa*, *Planorbis*, *Segmentina*, *Pomatiopsis*, *Valvata*, *Amnicola*, *Sphærium*, *Anodonta*, among fresh-water forms, and *Hyalina*, *Stenotrema*, *Helicodiscus*, *Conulus*, *Strobila*, *Helicina*, *Patula*, *Mesodon*, *Vallonia*, *Macrocyclis*, *Pupa*, *Succinea*, *Vertigo*, and *Cionella*, among the land forms. *Unio* is quoted by Drs. Hayden and Aughey from the loess of Nebraska. There are thus, of mollusks, eleven genera attributed to fresh-water, against thirteen genera to land forms. The single exception to varieties now living, as above noted, is *Helicina*, the species meant, *H. occulta* Say, being now extinct.[1] It may be properly considered the only species characteristic of the loess. From the loess of east Central Iowa, at Iowa City, the *chela* of a *Cambarus* is reported,[2] under circumstances which leave no doubt that it is from *true* loess.

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[1] At the present day the Missouri flows past the western boundary of Iowa at an average rate of five miles per hour (Pacific R. R. Rept., Vol. 1, p. 232). The fall per mile of this remarkable river, from the three forks of the Missouri to St. Joseph, varies from 31.59 to .88 feet, with an average for the whole distance of 1.55 + feet per mile. It annually discharges into the Mississippi about four trillions of cubic feet of water, and at the western boundary of Iowa it is not too great an estimate to assume an annual flow of two trillions of cubic feet of water, equaling one-tenth the whole discharge of the Mississippi. (See Humphrey's and Abbott's "Report on the Mississippi River," p. 49.) The amount of sediment *now* being contributed by the Missouri to the Gulf is remarkable. From specimens taken at Council Bluffs at both low and high water, Professor Emery determined the amount in one gallon of the former at fifty-two grains, and in an equal quantity of the latter at 404 grains. That, under the conditions prevailing at the time of the loess deposition, the amount of sediment was *very largely* in excess of these figures, is a fact beyond question, the material being, without doubt, furnished by the grinding of glaciers. These considerations should have their full weight in determining the dynamics of the loess of the Missouri region.

Of higher animals there have been found, especially in the Southern States, remains of *Mastodon*, *Megatherium*, *Mylodon*, *Megalonyx*, *Castor*, and *Fiber*, among others. Their remains and the relation of the loess to the drift, which, when both are present, it always covers, places its epoch at the close of the glacial period.

(To be continued.)

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ICHTHYOLOGICAL PAPERS BY GEORGE POWERS DUNBAR, WITH A SKETCH OF HIS LIFE.

BY JACOB L. WORTMAN.

A STUDY of the fishes of the Southern States is one replete with many points of interest for the naturalist, and had it not been for a series of misfortunes, the credit for the earliest research into this field would probably be due to an American student now unknown. It is the object of the present article, to give some information relating to the life and labors of this meritorious naturalist, which are of especial interest, since he was one of the first native-born Americans who made an extended study of the ichthyology of this region. The absence during his time of any periodical devoted to the natural sciences in this country, contributed much to his disadvantage, and as a consequence the technical descriptions were withheld in anticipation of an opportunity to publish. This unfortunate circumstance is one of the causes of his obscurity, and is in part answerable for the loss of his many excellent observations in this branch.

George Powers Dunbar was born in Baltimore, February 11th, 1812. Nothing of unusual interest was noticeable in his early childhood, except an innate love for a study of natural history, on

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[1] This statement now needs some modification. Since it was in type, a species of *Helicina* has been sent me in considerable abundance, taken in the vicinity of Iowa City. That they are *H. occulta* Say, is hardly to be doubted. The forms sent all approximate the variety described by Green as *Helicina rubella*.

[2] A. H. Pilsbury, *in litt.*